SYMPOSIUM ON UNDERGRADUATE RESEARCH

Division of Laser Science of A.P.S - LS XXIV - 20 October 2008 - Rochester, NY

PARTICIPANTS' LUNCHEON - Highland B - 12:00

The participants' lunch will bring together the Symposium students and the distinguished laser scientists who will speak later that afternoon at the Schawlow-Townes Symposium marking the 50th anniversary of the first laser paper. Three of these scientists are Nobel laureates: Charles Townes (1964), Nicolaas Bloembergen (1981), and Steve Chu (1997).

Box lunches will be provided for participants and invited guests only.

POSTER SESSION - Riverside Court - 12:30

Session SMA: 12:30 - 1:55 PM, Riverside Court - Martin Richardson, CREOL, Presider

SMA1 - **Light Detection for Laser Induced Breakdown Spectroscopy,** *James Martin, Matthew Weidman, Christopher Brown, Candice Bridge, Matthieu Baudelet, and Martin Richardson, Townes Laser Institute, College of Optics and Photonics, University of Central Florida, Orlando, FL 32816.* The collection of light emitted from organic thin films in LIBS is important in detecting biological or chemical substances. Methods of light detection for Filament-Laser Induced Breakdown Spectroscopy experiments will be discussed. Supported by NSF IREU program.

SMA2 - **Low frequency fluctuation (LFF) in the multi-mode regime of a vertical-cavity surface-emitting laser (VCSEL) with optical feedback,** *Justin HoShue, Amod Jung Basnet, and Hong Lin*, *Bates College, Lewiston, ME 04240.* We have studied instabilities induced by polarized optical feedback in a multi-transverse-mode VCSEL. The effects of injection current, external cavity length and feedback strength on the LFF have been investigated. Results show that fundamental mode plays a dominant role in LFF. Supported by a grant to Bates College from HHMI.

SMA3 - **Calcium Vapor Cell for Spectroscopy on the $4s^2\ {}^1S_0$ - $4s4p\ {}^3P_1$ Intercombination Line,** *Jose M. Guerrero, Christopher J. Erickson, and Dallin S. Durfee, Brigham Young University, Provo, UT 84602.* We discuss two methods to reduce the temperature required to achieve significant absorption on the $4s^2\ {}^1S_0$ - $4s4p^3P_1$ intercombination line in a calcium vapor cell. The first method increases the effective length of the cell through multiple passes. The second method employs state-changing collisions with a buffer gas. Supported by NSF.

SMA4 - **Theoretical Analysis of Mutually-Coupled Diode Laser Systems**, *K. Lee, J. McKay, B. Mooneyham, and D.W. Sukow, Washington and Lee University, Lexington, VA 24450.* A semiclassical, delay-differential model describes the dynamics of a system of two diode lasers with mutual coupling via orthogonal optical injection. Numerical simulations reproduce square waves, and analytical expressions predict properties of steady states, in agreement with experimental observations. Supported by NSF CAREER award.

SMA5 - **An Ultra-stable 657nm ECDL for a Calcium Atom Interferometer,** *James Archibald, Chris Erickson, and Dallin S. Durfee, Brigham Young University, Provo, UT 84602.* We report on the continued development and application of a kHz-level ECDL locked to an ultra-high finesse cavity and tuned to the $^1S_0$ - $^3P_1$ intercombination line in Calcium. We give a brief overview of the laser and the high-speed, low-drift electronics that we developed for this system. Supported by Research Corporation and BYU.

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SMA6 - **Creating an Ultra-stable 130mW Laser by Injection Locking,** *D. Merrill, C. Erickson, and D. Durfee, Brigham Young University, Provo, UT 84602.* To meet the requirements of a thermal beam calcium atom interferometer, we created an extremely stable 130 mW diode laser via injection locking to an ultra-stable master laser. We established a ceiling for the linewidth broadening between the two lasers by beating them with the slave laser modulated at 200 MHz. Supported by the College of Physical and Mathematical Sciences at BYU.

SMA7 - **Using Beat Frequency Line Shape To Analyze Laser Bandwidth,** *Daniel J. D'Orazio, Kenny Goodfellow, Amy Frantz, Brad Dinardo, and James D. White, Juniata College, Huntingdon, PA 16652*. Using saturated absorption spectroscopy, two diode lasers are locked to the peaks of adjacent hyperfine spectral lines in the rubidium absorption spectrum and made collinear to produce a beat frequency signal at ~30 MHz. This beat signal will aid in the search for a superior method for locking and stabilizing diode lasers. Supported by NSF.

SMA8 - **Radio Frequency Sputtering of $70TeO_2$-$10Bi_2O_3$-20ZnO Glasses,** *A. Haldeman[1], S. Perero[2], M. Ferraris[2], J. Massera[1], L. Petit[1], and K. Richardson[1] 1) School of Materials Science and Engineering, Clemson University, Clemson, SC 29634, 2) Department of Materials Science and Chemical Engineering, Politecnico di Torino, Torino, Italy*. This study focused on the fabrication and characterization of tellurite-based thin films of composition $70TeO_2$-$10Bi_2O_3$-20ZnO by radio frequency sputtering techniques. The properties of the films were compared to those of the bulk and fiber forms of the composition. Thermal treatments were pursued in attempt to reduce the differences between the film and bulk glass. Supported by the NSF International REU program.

SMA9 - **Optical Characterization of Coated Vacuum Windows for a Bose Einstein Condensation System,** *Laura Coyle[1] and Nicholas Bigelow[2], 1) Colgate University, Hamilton, NY 13346, 2) University of Rochester, Rochester, NY 14627.* We characterized one inch borosilicate window flanges coated for anti-reflection to be installed in the BEC lab's vacuum chamber for uniform transmission, aberration, and birefringence. Analysis of the window's optical quality will be presented. Supported by NSF through REU.

SMA10 - **Interference of Displaced Optical Vortices,** *Daniel Kalb and Kiko Galvez, Colgate University, Hamilton NY 13346,* Contrary to typical electromagnetic waves, a helical wave front contains optical vortices (or optical singularities), at which point the intensity of the light is zero. It is our goal to further understand this helical form of light by experimentally and mathematically examining the interference pattern between displaced optical vortices. Supported by a Grant by Colgate Alumni Justus '43 and Jayne Schlichting.

SMA11 - **Design and Construction of a High Vacuum System for use in Absolute Efficiency Measurements of a STIRAP-Excited Rydberg State (n=26) Helium Beam,** *Christopher Presuto, Jonathan Kaufman, Xiaoxu Lu, Yuan Sun, and Harold Metcalf, Stony Brook University, Stony Brook, NY 11794.* A high vacuum system is constructed for use in transition efficiency measurements of a STIRAP-excited Rydberg He beam. Light with $\lambda = 796$ nm and 389 nm is produced for this purpose via optically pumped Ti:Sapphire lasers and an LBO frequency doubling cavity. Various laser locking systems are in place to ensure frequency stability. Supported by NSF and ONR.

SMA12 - **Simple Gas Cell Used To Fill Hollow Core Optical Fiber With High-Pressure Gas For Optical Comb Generation By Raman Scattering,** *Cade Gledhill, Erin Mondloch, Chunbai Wu, and Michael G. Raymer, Oregon Center for Optics, University of Oregon, Eugene OR 97403.* We constructed a simple gas cell used to fill a hollow-core microstructured optical fiber with high-pressure hydrogen gas which, when pumped by a moderate power pulsed laser, produces a broad comb-like spectra by Raman scattering. We used only inexpensive commercial parts and very little machining. Supported by NSF-REU.

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SMA13 - **Magneto-Optical Trapping of ^{87}Rb with Distributed Feedback Lasers,** *Crystal Senko, Joel Greenberg, and Daniel Gauthier, Duke University, Durham, NC 27708.* We have constructed a magneto-optical trap for ^{87}Rb, and use this apparatus to investigate whether distributed feedback diode lasers can be used for cooling and trapping work. The trap was designed with an emphasis on simplicity and robustness, so that it can be incorporated into an undergraduate Advanced Laboratory course. Supported by Duke Physics Advanced Laboratory Endowment.

SMA14 - **Opto-Mechanical Shape Recognition,** *Margo Kinneberg and Rahul Khakurel, Vassar College, Poughkeepsie, NY 12604.* Shape recognition lends itself to many fields, but the current techniques are often complex or costly. Expanding on previous research involving the opto-mechanical integration of 2-D functions, we present multiple approaches to recognize shapes through opto-mechanical techniques with the aim of cheaply, quickly, and efficiently detecting and modeling shapes.

SMA15 - **Crystallographic Analysis in Preparation for Time-Resolved X-Ray Diffraction Studies,** *Jordan Cox[1], Anders Harpoeth[2], Michael Wörner[2], Thomas Elsässer[2], and Martin Richardson[1], 1) University of Central Florida, 2) Max Born Institute, Berlin, Germany.* An x-ray microfocus setup characterized ammonium sulphate and potassium dihydrogen phosphate crystal planes of unknown orientation. Supported by NSF International REU.

SMA16 - **Efficient second harmonic generation (SHG) of Ti:sapphire laser using non-linear BBO crystal,** *Roshita Ramkhalawon[1], Kyle Taylor[2], and Nicholas Bigelow[1], 1) University of Rochester, Rochester, NY 14627, 2) University of Wisconsin-Stevens Point, Stevens Point, WI 54481.* We describe the set up of a bow-tie optical resonator which is used to produce efficient second harmonic generation (SHG) light. We obtain 426 nm light by frequency doubling a 852 nm Ti:sapphire laser using a non-linear BBO crystal. Supported by NSF.

SMA17 - **Time-Resolved Spectroscopy of Self-Assembly of CCMV Protein Capsids,** *Jelyn Moore[1,2], Dina Aronzon[1], and Vinothan Manoharan[1], 1) Harvard University School of Engineering and Applied Sciences, Harvard University, Cambridge, MA 02138, 2) Hampton University, Hampton, VA 23668.* Our experiment examines the surface plasmon resonance of a colloidal gold particle to time resolve the self-assembly of a single virus. A spectral shift will determine the proximity of the virus to the gold nanoparticle. An evanescent wave detector will detect and analyze the shift in the absorbance spectra of the gold nanoparticle. Supported by NSF.

SMA18 - **Containing a Spinning BEC,** *Kristin Beck, Nicholas Bigelow, Azure Hansen, Suzanne Leslie and Kevin Wright, University of Rochester, Rochester, NY 14627.* Bose Einstein Condensates (BEC's) are currently being used to study the interplay of magnetism and vortex motion. To study the time evolution of such a system, a non-magnetic trap is required. Development toward such a trap using light with orbital angular momentum for an alkali atom BEC will be presented. Supported by NSF.

SMA19 - **Search for Collisional Exchange of Ground-State Atomic Alignment Between Rubidium Isotopes,** *Eric J. Bahr[1], D. F. Jackson Kimball[1], B. Coste[2], J. M. Higbie[2], M. P. Ledbetter[2], D. Budker[2], and S. A. Rangwala[3], 1) California State University - East Bay, Hayward, CA 94542, 2) University of California at Berkeley, Berkeley, CA 94720 , 3) Raman Research Institute, Bangalore 560080 India.* We report on a search for collisional transfer of ground-state atomic alignment between rubidium isotopes. Alignment-exchange cross sections for rubidium are suppressed relative to spin-exchange cross sections by four orders of magnitude. The results have implications for tests of fundamental physics.

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Group Photo Break 1:55 - 2:00 PM - - - PLEASE assemble at the designated place !!!

Session SMC: 2:00 - 3:45 PM, Highland B - Jenny Magnes, Vassar College, Presider

SMC1 - **Dynamics of Diode Lasers with Mutual Coupling by Rotated Optical Injection,** *B. Mooneyham, K. Lee, J. McKay, and D.W. Sukow, Washington and Lee University, Lexington, VA 24450*. Orthogonal optical injection in a system of mutually-coupled edge-emitting lasers can produce polarization-modulated square waves with a tunable duty cycle. The asymmetry in these square waves can be varied using system parameters such as pump current, alignment, and coupling strength. Experimental results and numerical simulations will be reported. Supported by NSF CAREER award.

SMC2 - **Towards Trapping of Atomic Tritium for Fundamental Tests of Beta Decay,** *Julia H. Majors, Melissa Jerkins, Joshua R. Klein, and Mark G. Raizen, University of Texas, Austin, TX 78712*. We propose first experiments with ultra-cold atomic tritium. We consider possible tests of beta decay and report an analysis of an experiment to determine the rest mass of the neutrino based on kinematic reconstruction. We also consider a neutrino Mossbauer experiment which would enable resonantly-enhanced detection of neutrinos.

SMC3 - **Propagation of Orbital Angular Momentum States of Light through Turbulent Media,** *Victoria Chan[1], Colin O'Sullivan[2], and Robert Boyd[2], 1) Smith College, Northampton, MA 01060 2) University of Rochester, Rochester, NY 14627.* We characterized the propagation of orbital angular momentum (OAM) states of light through turbulent media. Quantitative measurements were made to determine whether or not OAM states are good candidates for quantum cryptography. Preliminary results will be presented. Supported by NSF and MIT-Lincoln Lab.

SMC4 - **A Simplified $\pi/2$ Astigmatic Laser Mode Converter,** *Hamsa Sridhar, Martin Cohen, and John Noé, Laser Teaching Center, Stony Brook University, Stony Brook, NY 11794.* We describe a versatile and effective $\pi/2$ astigmatic laser mode converter based on a single cylinder lens; the conventional design utilizes two such lenses. The converter readily produces high-quality optical vortex beams from exact or approximate Hermite-Gauss modes. Supported by NSF-REU.

SMC5 - **The Effect of Artificial Planar Chiral Nanostructures on Light Polarization,** *Daniel Klein[1], Ksenia Dolgaleva[2], and Robert W. Boyd[2], 1) Tufts University, Boston, MA 02155, 2) University of Rochester, Rochester, NY 14627.* We investigated the effects of several chiral nanostructures on linearly polarized laser light using a 632-nm Helium-Neon laser, confirming and expanding upon the results of a previous experiment.

SMC6 - **Ghost Imaging Using a Pseudothermal Light Source,** *Aaron Bauer[1], Colin O'Sullivan[2], and Robert Boyd[2], 1) University of Wisconsin – Eau Claire, Eau Claire, WI 54701, 2) University of Rochester, Rochester, NY 14627.* Ghost imaging is a process where an image is formed in a setup where the object and imaging detector are on separate optical paths. We explore the dependence of the ghost image quality on various experimental parameters. Supported by NSF-REU.

SMC7 - **Measurement of the Linewidth of Trivalent Thulium Fiber Lasers,** *Matthew Reichert[1], Vikas Sudesh[2], and Martin Richardson[2], 1) Rose-Hulman Institute of Technology, Terre Haute, IN, 47803, 2) CREOL, University of Central Florida, Orlando, FL 32816.* This project was to measure the linewidth of a trivalent thulium fiber lasers, with both a Volume Bragg Grating (VBG) based, and a Guided Mode Resonance Filter (GMRF) based. A Fabry-Perot Interferometer was used to measure the laser linewidth.

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Session SME: 4:00 – 5:45 PM, Highland B - David Sukow, Washington and Lee, Presider

SME1 - **Processing and Characterization of New Oxysulfide Glasses in the Ge-Sb-S-Te-O System,** *C. Smith, L. Petit, and K. Richardson, School of Materials Science and Engineering, Clemson University, Clemson, SC 29634,* We describe a new technique to prepare oxysulfide glasses. Their physical, thermal and optical properties have been measured and compared as a function of O/S ratio. Raman spectroscopy was used to evidence structural modification with the introduction of oxygen. Supported by NSF, Univ. of Central Florida, CREOL and Clemson University.

SME2 - **Investigations of the Performance of a ^{87}Rb Magneto Optical Trap,** *Jeffery C. Solberg and John R. Brandenberger, Lawrence University, Appleton, WI 54912.* We report on investigations of the operation and performance of a ^{87}Rb magneto optical trap (MOT) at Lawrence University. We discuss various diagnostics that provide characterization of this MOT as well as preliminary investigations of whether the cold ^{87}Rb cloud resembles an ideal gas. This work was supported by gifts from D. L. Skran, E S. Bliss,G. N. Peterson, B. Schneider.

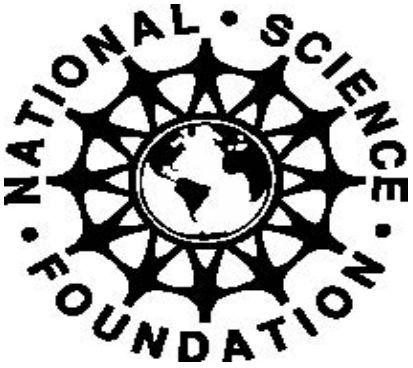
SME3 - **Atomic Parity Nonconservation in Ytterbium,** *A. Family, K. Tsigutkin, D. Dounas-Frazer, and D. Budker, University of California, Berkeley, Lawrence Berkeley Laboratory, Berkeley CA 94720.* We discuss experiments aimed at measurements of atomic parity nonconservation (PNC) effects in Ytterbium (Z = 70). The experiment will determine differences in PNC effects between different hyperfine components for odd-neutron-number Yb isotopes.

SME4 - **Design of a Microwave Fabry-Perot Cavity to Drive a Parity Forbidden Transition,** *Jonathan Hood, Adrian Perez-Galvan, Dong Sheng, and Luis Orozco, University of Maryland, College Park, MD, 20742.* Weak interactions within the nucleus make an otherwise parity forbidden electron transition possible. Our experiment proposes to learn about nucleus's structure by driving a forbidden hyperfine transition. An atom is trapped in a standing wave of a microwave Fabry-Perot cavity. This talk discusses the cavity's design and preliminary results. Supported by NSF.

SME5 - **Nuclear Quadrupole Interaction in an NMR Gyroscope,** *Jonathan L. Long[1] and Elizabeth Donley[2] , 1) Carnegie Mellon University, Pittsburgh, PA 15289, 2) NIST Time and Frequency Division, Boulder, CO 80305.* We studied the quadrupole interaction of Xe-131 and its continuous transformation from the pure quadrupole regime to the quadrupole perturbed Zeeman regime. Our experiment relies on spin exchange optical pumping in a 1mm^3 micro-fabricated cell of silicon and Pyrex. Good agreement is found with theoretical predictions. Supported by NSF and DARPA.

SME6 - **Quantitative Analysis of Steel Samples using Laser Induced Breakdown Spectroscopy,** *Jonathan Meair[1], B. Bousquet[2], and L. Canioni[2], 1) Rennselaer Polytechnic Institution, 2) University of Bordeaux I, Bordeaux, France.* We used Laser Induced Breakdown Spectroscopy to determine the concentration of various elements within steel samples. Numerical techniques and physical considerations were used to minimize the error in the predicted concentrations due to phenomena such as self-reversal, matrix effects, and variation between replicate measurements. Supported by NSF through IREU.

SME7 - **Thermal Lensing in Faraday Isolator**, *John Golden[1] and Eric Genin[2], 1) University of Rochester, Rochester, NY 14627, 2) European Gravitational Observatory, Cascina, Italy.* To achieve greater sensitivity in the Virgo interferometer, a higher power laser must be used. This will have the side effect of heating the crystal inside the Faraday Isolator, which will induce thermal lensing. It is necessary to model this effect and introduce a second crystal with appropriate optical properties to correct for this lensing. Supported by NSF-IREU.



Symposium organized by Harold Metcalf and John Noé, Stony Brook University